

FLEXIBLE WIND ABATEMENT SYSTEM

1 This application is a continuation-in-part of S.N.
2 09/565,211 which is a continuation of S.N. 09/270,249, now U.S.
3 Pat. No. 6,176,050 B1, which is a continuation-in-part of S.N.
4 08/861,209, now abandoned. The content of all the prior
5 applications and the prior art cited in each of the
6 applications is incorporated herein by reference.

7

8 Technical Field

9 This invention relates to the protection of property
10 against high winds and, in particular, to a flexible protective
11 barrier device for securing property from damage from the wind
12 itself and from the impact of foreign objects carried by wind
13 as occasioned by hurricanes, tornadoes and the like.

14

15 Background Art

16 As is known by one skilled in the art of protecting
17 buildings and the like from damage caused by missile-like
18 objects that are occasioned by the heavy winds of hurricanes or
19 tornadoes, there are commercially available variations of
20 hurricane protective devices, often called shutters, that
21 fasten immediately over the frangible area to be protected.
22 These devices are typically expensive to purchase, cumbersome,

1 made from stiff, heavy material such as steel and aircraft
2 quality aluminum alloy or occasionally plastic with
3 reinforcing. Many need to be manually connected and then
4 removed and stored at each threat of inclement weather. Many
5 require unsightly and difficult-to-mount reinforcing bars at
6 multiple locations. Further, these known shutters are usually
7 opaque, preventing light from entering a shuttered area and
8 preventing an inhabitant from seeing out. Likewise, it is
9 desirable that police be able to see into buildings to check
10 for inhabitants and to prevent looting which can be a problem
11 in such circumstances. Missiles, even small not potentially
12 damaging missiles, striking these heretofore known shutters
13 create a loud, often frightening bang that is disturbing to
14 inhabitants being protected.

15 Standardized testing requiring these protective devices
16 to meet certain standards of strength and integrity has been
17 introduced for various utilizations and locales. In order to
18 qualify for use where said testing requirements apply, the
19 strength and integrity characteristics of these protective
20 devices must be predictable and must be sufficient to meet said
21 standards. Additionally, and as is obvious to one skilled in
22 the art, it is beneficial to qualify for said standards even in
23 situations in which standards do not apply. As a result of
24 said standards, many undesirable aspects of the heretofore

known shutters have been acerbated. They have become more cumbersome, more bulky, heavier, more expensive, more difficult to store, and remain generally opaque and noisy when impacted. To incorporate sufficient strength to meet said requirements, weight and bulk become a problem over six feet in span. The useable span (usually height) of the heretofore known shutters that meet said standards may be limited to eight feet or less. This makes protecting large windows, for example, or groupings of windows, with the heretofore known devices cumbersome, expensive and impractical. Devices that are intended to be deployed in a roll down manner either manually, automatically, or simply by motor drive, have been difficult to strengthen sufficiently to pass the test requirements and require unsightly reinforcing bars every few feet.

Prior to the introduction of said standards, an ordinary consumer had very little useful knowledge of the strength and integrity of said shutters. It is believed shutters of the pre-standard era were very weak such that all would fail the present standardized testing. It should be understood that the standards are not intended to provide a shutter that will protect in all situations. As the hurricane conditions can be very violent and destructive, the standards are not intended to require strength and integrity sufficient to protect in all circumstances. The standards simply provide a benchmark as to

1 strength and integrity. Said strength and integrity of the
2 shutters can now be measured.

3 There are a sundry of patents that teach the utilization
4 of knitted or woven fabric such as netting, tarpaulins, drop
5 cloths, blankets, sheets wrapping and the like for anchoring
6 down recreational vehicles, nurseries, loose soil and the like.
7 But none of these are intended for, nor are capable of
8 withstanding the forces of the missile-like objects that are
9 carried by the wind in hurricanes. Examples where fabric or
10 netting material that encapsulates the unit to be protected as
11 by covering the entire unit and fastening the ends of the
12 fabric to the ground are disclosed in the following patents.
13 United States Patent Nos. 3,862,876 issued to Graves, 4,283,888
14 and 4,397,122 issued to Cros, 4,858,395 issued to McQuirk,
15 3,949,527 issued to Double et al., 3,805,816 issued to Nolte,
16 5,522,184 issued to Oviedo-Reyes, 4,590,714 issued to Walker
17 and 5,347,768 issued to Pineda. The 5,522,184 patent for
18 example, provides a netting that fits flush over the roof of a
19 building and uses a complicated anchoring system to tie down
20 the netting to strengthen the building structure against
21 hurricanes and wind storms.

22 Certain types of flexible material that are capable of
23 withstanding high wind loading or impact loads without
24 bursting, can be disposed in front of the building or other

1 structures intended to be protected, and anchored on opposing
2 edges, to form a curtain sufficiently spaced from the frangible
3 area to contain the impact of foreign objects hurled by the
4 high winds. For example, in a building the top edge of the
5 fabric may be anchored to the eave of the roof and the bottom
6 of the fabric may be attached to anchors imbedded in the ground
7 or cement, so as to present a curtain adequately spaced out
8 from and in front of the structure of the building to be
9 protected. Not only does this afford frontal protection but,
10 properly located and attached, it also serves to tie down the
11 roof and protect it from blowing off. The winds that would
12 ordinarily blow off the roof exert a force on the fabric which,
13 in turn, exerts a downward force on the roof to act against the
14 lifting forces tending to lift the roof.

15 Thus, what is lacking in the art is a flexible protective
16 barrier constructed from a mesh material that can be easily
17 stored and deployed for protecting the frangible portion of a
18 structure from objects carried by the wind.

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1 Summary of the Invention

2 This invention contemplates the use of a flexible barrier,
3 preferably a reasonably transparent, woven synthetic textile
4 that is able to satisfy stringent testing requirements.
5 Knitted or extruded material can be an alternative if the
6 material itself meets the criteria described later herein. The
7 use of this invention allows very large areas with spans of
8 greater than 25 feet to be covered with ease. Thus most window
9 groupings, even several stories of a building, could be readily
10 protected. This invention is light in weight, easy to use,
11 does not require reinforcing bars, can be constructed in
12 varying degrees of transparency, can be weather tight, is
13 economical, and is capable of dissipating far greater forces
14 without damage than the heretofore known stiff devices.
15 Missiles striking this barrier make very little sound. This
16 invention is suitable to be configured with the necessary motor
17 and supportive devices for automatic deployment.

18 Heretofore known devices have internal stiffness and
19 rigidity that resists deflection, or bending. It is this
20 stiffness that stops the missile short of the frangible surface
21 being protected. This invention does not have rigidity but
22 rather is very flexible, which give several positive features
23 including allowing for ease of storage as by rolling or
24 folding. The flexible barrier of the invention is placed a

1 distance out from the surface to be protected. An impacting
2 missile stretches the barrier until it decelerates to a stop or
3 is deflected. The barrier material has a predetermined tensile
4 strength and stretch that makes it suitable for this
5 application. Said known strength and stretch, together with
6 the speed, weight and size of the impacting missile, all of
7 which are given in test requirements, permit design calculation
8 to ascertain barrier deflection at impact. This deflection is
9 a determinate of the minimum distance that this barrier is to
10 be spaced out from the frangible area to be protected. Other
11 determinates which may be included are additional deflection
12 from wind pressure and from slack from an improper
13 installation.

14 The barrier of this invention is mounted farther away from
15 the surface to be protected than the prior art structures,
16 thereby providing room for a longer deceleration of impacting
17 flying debris (missiles). Thus greater energy from a missile
18 can be safely dissipated than is possible with the prior art
19 structures, and the energy which can be safely dissipated is
20 calculable.

21 The distance which the barrier is spaced out from the
22 frangible surface need not be great and is quite workable with
23 existing structures. Even though the distance is not great,
24 said distance does allow a significantly increased distance and

1 time of deceleration such that the barrier will stop far
2 stronger impacts than with the heretofore known rigid devices.
3 In simple terms, the missile is slowed to a stop by elasticity
4 as the barrier stretches. The greater the impact, the greater
5 the stretch. Thus the building is not subjected to an abrupt
6 harsh blow as the impact on the shutter is transferred to the
7 building. The energy transfer is much gentler and less
8 destructive than with the rigid devices.

9 It will be obvious to one skilled in this art that this
10 device goes beyond merely hanging a curtain in front of a
11 structure and hoping wind born missiles will be stopped. This
12 invention provides a method of calculating the minimum spacing
13 of said barrier from the frangible surface and provides
14 understanding as to the strength and integrity of said barrier.
15 This invention contemplates using a screen-like fabric with
16 interstices that permit the light to pass through and that is
17 reasonably transparent. Of course, if interstices are utilized
18 in the fabric makeup, the size of the interstices must consider
19 the size of the missiles such that the missiles do not pass
20 therethrough. If transparency is not desirable, the fabric can
21 be made sufficiently dense to minimize or eliminate the
22 interstices. To assure a long life, the material of the fabric
23 preferably would be resistant to the ultra violet radiation,
24 and to biological and chemical degradation such as are

1 ordinarily found outdoors. This invention contemplates either
2 coating the material or utilizing material with inherent
3 resistance to withstand these elements. A synthetic material
4 such as polypropylene has been found to be acceptable. An
5 example of a coated material is vinyl coated polyester.
6 Materials intended to be used outdoors in trampolines, for
7 example, are likely candidates for use in this invention.
8 Black colored polypropylene is most resistant to degradation
9 from ultra violet radiation. Other colors and vinyl coated
10 polyester are sufficiently resistant, particularly if the
11 barrier is not intended to be stored in direct sunlight when
12 not in use.

13 The preferred embodiment allows air passage through it,
14 albeit at substantially reduced rate. An upwind pressure of 1"
15 of mercury, which roughly translates into a 100 miles per hour
16 (mph) wind, forces air through at 250 cubic feet per minute
17 (cfm) or approximately 3 mph. The amount of air passage
18 depends on the interstice size. If a weather tight and
19 transparent barrier is desired, the polypropylene material may
20 be laminated with a flexible clear plastic skin.

21 It is of importance that the material affords sufficient
22 impact protection to meet the regulatory agencies' requirements
23 in order for this to be a viable alternative to other hurricane
24 protective mechanisms. While stiff structures, such as panels

1 of metal, are easily tested for impact requirement and have
2 certain defined standards, fabrics on the other hand, are
3 flexible and react differently from stiff structures. Hence
4 the testing thereof is not as easily quantified as the stiffer
5 materials. However, certain imperial relationships exist so
6 that correlation can be made to compare the two mediums.
7 Typically, the current impact test of certain locales requires
8 a wood 2x4 stud be shot at the barrier exerting a total force
9 of approximately 230 pounds, or 61.3 pounds per square inch
10 (psi), over its frontal (impacting) surface. This impact and
11 resultant force relate to the Mullen Burst test commonly used
12 by manufacturers to measure the bursting strength of their
13 fabrics. Thus the impact test heretofore used on rigid devices
14 will work equally well on this flexible device.

15 The preferred embodiment of this invention would use a
16 textile of the type typically used in trampolines which would
17 burst at 675 psi or a total of 2,531.25 pounds over the same
18 3.75 square inch frontal surface of the nominal 2x4 test
19 missile and would stretch 21% immediately prior to failure. .
20 The strength and stretch characteristics of the material are
21 known. The strength of this fabric is more than eleven (11)
22 times the 230 pounds of strength required to withstand the
23 above-described 2x4 missile test as presently required by said
24 regulatory agencies. Stronger fabrics are available. Others

1 are available in various strengths, colors and patterns. The
2 maximum deflection can readily be calculated and hence the
3 distance that the fabric must be spaced from the surface being
4 protected can be easily ascertained.

5 As one skilled in this art will appreciate, the reason for
6 the utilization of stiff materials for protection against the
7 high winds and missile-like objects propelled thereby is
8 because heretofore known barriers are mounted close to the
9 frangible object being protected. Obviously, if the protective
10 material is mounted close to the protected surface, it must
11 necessarily be stiff in order to stop the missile short of the
12 protected frangible surface. In such a situation, impacting
13 missiles are required to come to an abrupt stop. Such abrupt
14 stop of the missile on impact with the surface of the
15 protecting structure is less desirable because the rapid energy
16 dissipation has the propensity to cause damage not only to the
17 protective device, but to the structure being protected as
18 well. An extended controlled deceleration is not available if
19 the barrier is mounted close to the frangible surface.

20 The use of flexible fabric distanced out from the
21 frangible area as a protective barrier allows extended
22 deceleration. When the strength and stretch properties of the
23 fabric are known and allowed for, the extended deceleration
24 becomes controlled. By mounting the protective barrier some

1 distance from the frangible surface, a distance that is
2 calculable, the missile can be decelerated to a stop prior to
3 contacting the frangible surface. In other words, in any
4 situation where the missile must stop prior to impacting the
5 frangible surface being protected, it is desirable to
6 decelerate the missile through an extended controlled
7 deceleration. This invention does precisely that.

8 An extended deceleration has much less propensity to cause
9 damage than an abrupt deceleration. Since the use of a
10 flexible material as a protective barrier affords an extended
11 deceleration, very strong impacts can be withstood. It is
12 contemplated that this invention, using the proper material and
13 the proper assembly, will be sufficient to meet all foreseeable
14 impact test requirements and regulations for wind and debris
15 protection. Such requirements and regulation would include
16 more severe tests being contemplated for specialized, high
17 protection, shelters.

18 Thus, an object of this invention is to provide a barrier
19 made from fabric to protect the frangible portions of a
20 building and the like. A feature of this invention is spacing
21 the barrier out from and in front of the frangible area to be
22 protected by attaching two opposing edges to anchors located so
23 as to position the barrier as described. Another feature is
24 the formula for calculating minimum spacing.

1 For example, one edge of the fabric can be anchored to the
2 overhang of the roof or other high structure and the opposite
3 edge of the span to the ground or low structure to provide a
4 barrier spaced from and in front of the object to be protected.

5 The lower anchors can be attached to the ground by imbedding
6 in cement or other ground attachment such as tie downs or
7 stakes and the like and providing grommets, rings or other
8 attachments in the fabric to accept a clamp, cable, rope, and
9 the like. The barrier is sufficiently spaced from the
10 structure being protected in order to absorb and dissipate the
11 energy from impact prior to the impacting object reaching the
12 structure. The deceleration of the impacting object is
13 extended in comparison to a stiff barrier.

14 The curtain-like barrier of this invention is
15 characterized as a reasonably transparent barrier with strength
16 and simplicity that is unattainable with the heretofore known
17 barriers. Wind loading on windows is eliminated. Impact by
18 a missile does not cause a large bang, and is not disturbing.
19 Frame harmonics are reduced or eliminated, such harmonics are
20 known to cause catastrophic failure of structures. The
21 envelope of the structure is secured even if a window has
22 failed. Wind lift is spoiled to prevent uplifting of roofs.

23 It is easy to install, requires low maintenance and has
24 low acquisition cost. There is much flexibility with storage.

1 It can either be left in place or rolled much as a shade, or
2 slid out of the way much as a curtain, so as not to obstruct
3 the translucent of the window or interfere with the aesthetics
4 of the building. It can also be fully removed and stored out
5 of the way, or swung up to form a canopy when not in use as a
6 protective barrier. It is preferable but not essential, that
7 the material selected to be used in the netting fabric of this
8 invention be inherently resistant to elements encountered in
9 the outdoors or can be coated with coatings that afford
10 resistance to these elements. Another feature of this
11 invention is that it is capable of providing the dual function
12 of protection against flying missiles as well as providing
13 anchoring capabilities, such as tying down the roof of the
14 building or structure being protected to prevent it from being
15 lifted off.

16 Another feature of this invention is that it can be
17 reasonably transparent if desired without adversely affecting
18 the integrity of the barrier.

19 Another objective of this invention is that wind loading
20 on windows is eliminated wherein the wind load is transferred
21 to the surrounding support structure.

22 Still another objective of this invention is to reduce or
23 eliminate structure harmonics caused by high winds and the
24 resulting structure failure caused by such vibrations.

1 Yet still another objective of this invention is to
2 maintain the envelope of the structure to prevent uplifting of
3 the roof support by wind entering of the structure.

4 Another objective of this invention is to provide a means
5 to spoil wind lift that may be otherwise cause a roof structure
6 to detach from a structure.

7 Another feature of this invention is that missile impact
8 is reasonably quiet and not a loud frightening bang as with
9 heretofore known rigid devices.

10 Other objectives and advantages of this invention will
11 become apparent from the following description taken in
12 conjunction with the accompanying drawings wherein are set
13 forth, by way of illustration and example, certain embodiments
14 of this invention. The drawings constitute a part of this
15 specification and include exemplary embodiments of the present
16 invention and illustrate various objects and features thereof.

17

18

1 Brief Description of Drawings

2 Fig 1. is a partial view in perspective and schematic
3 illustrating this invention in the deployed position and
4 attached a building;

5 Fig. 2 is a partial view in section illustrating mechanism
6 for tying down the protective barrier;

7 Fig. 3 is a perspective of the barrier fabric;.

8 Fig. 4 is a detailed showing of alternative mechanism for
9 attaching the barrier to a structure;

10 Fig. 5 is a partial view illustrating a panel edge
11 closing;

12 Fig. 6 is a partial section of a tie-down;

13 Fig. 7 is a partial section of another tie-down along line
14 7-7 of Fig. 8;

15 Fig. 8 is a perspective, partly in section, of the tie-
16 down of Fig. 7;

17 Fig. 9 is a perspective, partly in section, of a ground
18 anchor and connection to the barrier;

19 Fig. 10 is a perspective of an edge closure; and

20 Fig. 11 is a perspective of another edge closure.

1 Detailed Description of the Preferred Embodiment

2 The invention does not derive its strength from stiffness
3 or rigidity but rather from its bursting strength and stretch,
4 with the latter acting like a spring to gradually decelerate
5 any impacting missile. To be able to calculate the minimum
6 distance that the barrier must be placed out from the area to
7 be protected, the frontal area, weight and speed of the test
8 missile must also be known. Wind speed may become a
9 significant factor in large spans.

10 There are many additional desirable characteristics of
11 this invention such as transparency, resistance to weathering,
12 light weight, ease of installation, deployment and storage,
13 economy.

14 While this invention is shown in its preferred embodiment
15 as being utilized to protect the windows and overhang roof of
16 a structure, it is to be understood that this item has utility
17 for other items requiring protection and is applicable to other
18 types of structures. Where appropriate, the barrier can be
19 deployed horizontally or at any angle as well as the vertical
20 as shown in Fig. 1.

21 Reference is now made to Figs. 1 which shows a building
22 structure 10 intended to be protected from the onslaught of
23 winds and debris typically occasioned during a hurricane. Fig.
24 1 shows barrier 61 deployed to completely envelop the building

1 structure 10. In this embodiment, the roof 68 is completely
2 covered by barrier panel 61 which has integral side panels 62
3 and 64 which extend from the roof to the ground. A
4 shorter end panel 62 protects the end of the building and
5 longer front panel 64 covers the front of the building. Of
6 course, these panels are duplicated at the other end and rear
7 of the building. As shown, the side panels are sloped
8 outwardly from the roof toward the ground. This orientation
9 creates a gap between the panels at the corners of the
10 building. A joining panel 63, shown in Fig. 1, connects the
11 adjacent side panels and provides a continuous barrier
12 surrounding the structure. A joining panel is in place at all
13 four corners of the building.

14 Fig. 2 illustrates an anchoring system 65 that provides
15 a tie-down for the barrier side panels and joining panels which
16 provides a holding power at least equal to the burst strength
17 of the barrier material. As shown, the side panel 62 has a
18 continuous folded reinforced hem 69 attached to an anchoring
19 strap 66. The strap 66 is passed through the eye of a ground
20 anchor 72. The ground anchor 72 is similar to the ground
21 anchor 110, shown in Fig. 9. The free end of the strap 66 is
22 threaded through a friction buckle 67 which has a locking

1 roller 82. As tension is applied to the strap 66, the friction
2 grip of roller 82 increases.

3 The upper margin of the side panels may have a batten 70,
4 as shown in Fig. 4. The upper edge of the side panels may be
5 attached to the roof beyond the batten (not shown). The batten
6 70 may be attached to the building over the eave 71 or to the
7 barrier. The batten 70 serves the dual purpose of protecting
8 the edge of the roof and providing a large diameter, smooth
9 surface about which the barrier turns approximately 90 degrees.
10 The batten may be made of any material which will not deform
11 under the compression and shear created by the barrier under a
12 wind load.

13 A suitable material for the barrier 61 is polypropylene
14 formed in a monofilament and woven into a geotextile (style
15 20458) manufactured by Synthetic Industries of Gainesville,
16 Georgia. The fabric is woven in a basket (plain) weave as
17 shown in Fig. 3 where the fill 11 and warp 13 threads
18 alternately cross over and under adjacent fills and warps. In
19 the preferred embodiment the interstices are substantially
20 equal to 0.6 millimeters which approximates the interstices of
21 commercially available residential window screening.

22 The barrier fabric may be coated or have inherent
23 resistance to withstand the elements. A synthetic material
24 such as polypropylene has been found to be acceptable. Also,

1 a vinyl coated polyester may be used in the barrier. Materials
2 intended to be used outdoors in trampolines, for example, are
3 likely candidates for the barrier material. Such materials
4 have a burst or failure limit of 675 pounds per square inch
5 (psi). Black colored polypropylene is most resistant to
6 degradation from ultraviolet (UV) radiation.

7 The preferred embodiment has air permeability albeit at
8 substantially reduced rates. An upwind pressure of 1 inch of
9 Mercury (Hg.), which is roughly equivalent to 100 miles per
10 hour wind speed, forces air through the material at
11 approximately 250 cubic feet per minute (cfm) or approximately
12 3 mph. The amount of air permeability depends on interstice
13 size. If a weather tight and transparent curtain is desired,
14 the polypropylene material may be laminated with a flexible
15 clear plastic skin.

16 The selection of interstice size and configuration is
17 dependent on the amount of transparency and air passage desired
18 and the limitation that the maximum size must be sufficiently
19 small to prevent objects that are potentially damaging on
20 impact from passing therethrough. The above mentioned
21 regulations set in place by Dade County, Florida have
22 determined that the smallest diameter missile (wind blown
23 debris) with which they are concerned is 3/8 inch in diameter.
24 Therefore to satisfy the Dade County Regulations the

1 interstices must be small enough to prevent 3/8 inch diameter
2 missiles from passing therethrough. Other regulations may set
3 other minimum missile diameter sizes. The interstice size
4 would similarly relate thereto if the barrier were intended to
5 satisfy said other regulations.

6 The endurance, physical, hydraulic and mechanical
7 properties of the textile are recorded and available from the
8 manufacturer, Synthetic Industries. It is important to this
9 invention that whatever type of material is utilized, the
10 fabric made up from this material must exhibit sufficient
11 impact strength for resisting the test impact loads at least to
12 the values dictated by the various industrial, insurance and
13 government regulating agencies. This particular fabric has
14 been shown to be able to withstand forces at over 11 times the
15 test load required by the regulating agency presently in the
16 forefront of standard setting.

17 The material selected must meet certain strength criteria.
18 These criteria, together with the size of span covered by the
19 barrier, constitute the basis for calculating the spacing of
20 the barrier from the object being protected. Said spacing is
21 calculated as follows:

22 1) The fabric must be sufficiently strong that the impact
23 force it is required to withstand is less than the failure
24 force (Mullen Burst).

1 2) The impact (test) force is then divided by the force
2 required to cause failure (Mullen Burst). This quotient is
3 then multiplied by the known stretch at failure to obtain the
4 stretch factor. The woven polypropylene synthetic fabrics of
5 the type used in the preferred embodiment stretch 20 - 22% just
6 prior to failure, depending on manufacturing technique. This
7 stretch information is available from the manufacturer.

8 3) The actual stretch measurement is then calculated and
9 in conjunction with the span of the barrier used to ascertain
10 the maximum deflection. This maximum deflection is the minimum
11 distance the barrier should be spaced from the frangible object
12 being protected.

13 EXAMPLE:

14 The preferred embodiment is used as an example to
15 demonstrate this formula. The preferred embodiment is a
16 polypropylene, woven monofilament geotextile. The
17 individual filaments are woven into a basket weave network
18 and calendered so that the filaments retain dimensional
19 stability relative to each other. This geotextile is
20 resistant to ultra violet degradation and to biological
21 and chemical environments normally found in soils. This
22 fabric is often used as the mat for outdoor trampolines
23 and is intended to be very resistant to weathering. The
24 fabric is known to stretch a maximum of 21% prior to

1 failure and requires a force of 675 psi to fail.

2 1. The present test that was originally legislated by
3 Dade County Florida and may become the standard in the
4 industry, requires the barrier to withstand a force of
5 only 61.3 psi. Consequently the fabric meets and
6 exceeds the first requirement of strength.

7 1. The stretch factor calculation is (test load /
8 maximum load x %stretch at maximum load = stretch
9 factor) $61.3 / 675 \times 21 = 1.9\%$. This becomes a
10 constant factor insofar as this fabric and the Dade
11 test remain involved. The calculation will change
12 if any one or more of the strength, energy or
13 stretch characteristics of the test or fabric are
14 modified. Likewise, it is known that stretch varies
15 directly with force up to the maximum at failure. To
16 calculate the actual stretch, the calculation is
17 stretch factor x height = actual stretch. Therefore
18 if the distance between the two fastened sides is
19 eight feet (96 inches), the stretch measurement will
20 be $96 \times 1.9\% = 1.83"$.

21 2. To calculate the deflection, right triangles are
22 used such that the hypotenuse is $\frac{1}{2}$ of the sum of
23 the height plus stretch ($97.83/2 = 48.92"$). The
24 known side is $\frac{1}{2}$ of the height ($96/2 = 48"$). Thus

the deflection = the square root of the difference between the square of the hypotenuse less the square of the known side. This result is 9.4" which is the maximum deflection on impact by test missile.

3. Thus to meet the prescribed standard the barrier must be mounted so as to be spaced at least 9.4 inches from the surface to be protected if an eight (8) foot span is to be used. A longer span will require wider spacing, a shorter will require less. The table shown below reflects this spacing for various sample distances of span with this preferred fabric.

Table demonstrating relationship between
Span and Maximum Deflection in the
Preferred Embodiment as Described Above.

Height	Deflection
8 feet	9.4 inches
10 "	11.8 "
12 "	14.1 "
14 "	16.5 "
16 "	18.8 "
18 "	21.2 "
20 "	23.5 "
22 "	25.9 "
24 "	28.2 "
30 "	35.2 "
40 "	47.0 "

1
2 The aforementioned formula is sufficient to provide
3 spacing to meet the test standards. As the spacing is intended
4 to be minimum, and although the barrier is intended to meet or
5 exceed test standards as opposed to warranting protection in
6 actual situations which are difficult to predict, this
7 invention can include an additional factor in the spacing to
8 allow for maximum wind pressure. Arbitrarily assuming a 115
9 mph wind at 90 degrees to the barrier and assuming the barrier
10 has been made weather tight with no air flow through the
11 barrier to somewhat relieve pressure, and assuming the barrier
12 is installed at sea level where air is densest, the additional
13 pressure on the barrier will be .237 pounds per linear inch of
14 span. This additional pressure can be resolved into a vector
15 and added directly to the test force of 61.3 pounds. Thus an
16 8 foot barrier will have an additional $(.237 \times 96 =)$ 22.75
17 pounds added for a total of 84.05 pounds. A 40 foot barrier
18 will have $(.237 \times 480 =)$ 113.76 pounds added for a total of
19 175.06 pounds. This number should be substituted into the
20 above formula to give a more accurate calculation of minimum
21 spacing.

22 For example: an 8 foot barrier could deflect 10.9" when
23 allowing for a 115 mph wind factor rather than 9.7" if the wind

1 was not factored in. The deflection of a 40 foot barrier
2 becomes 80.28" (6.69') rather than 47" (3.9').

3 Obviously, once the minimum space between the barrier and
4 the structure being protected is established, the fabric must
5 be anchored in a suitable manner so as to absorb the loads
6 without being torn from its support. In some installations,
7 the building may have adjacent areas, such as a patio or pool
8 deck or drive way, with concrete, cement or other materials.
9 In such cases, as shown in Fig.s 6 and 7, the lower edge is
10 fastened by anchors set in recesses 22 formed into the cement
11 to bury or partially bury eyebolts 24. The eyebolts 24 are
12 permanently screwed into the remaining portion of the cement.
13 Obviously this invention contemplates other methods of
14 anchoring the top and bottom of the curtain panels depending on
15 the particular application.

16 In Fig. 9, the a ground anchor 110 is used to secure the
17 barrier to the earth. These anchors may vary in design to
18 provide the requisite holding power in different soils. The
19 designs include ground anchors typically used to secure
20 telephone pole guy wires to the ground. In Fig. 9, the anchor
21 110 has an eye 116 coupled to a clamp 112 similar to clamp 32.

22 Equally obvious is the fact that the sides of the panels
23 where appropriate can likewise be anchored. As shown in Fig.
24 5, side edges of mating panels may be provided with releasable

1 fasteners 76. As shown, the fastener is in the form of a
2 zipper but other fasteners may be employed, such as hooks-and-
3 eyes, grommets-and-turn posts, male-and-female snaps, or
4 button-and-holes. The fastener 76 is protected by a fly 73
5 attached along the length of the fastener to one panel. The
6 fly has a cohesive closure, such as Velcro, with the
7 cooperating tapes 78 disposed on the free edge of the fly and
8 on the other panel. As shown, the joining panel 63 has a
9 releasable fastener 76 along one edge and a fly 73 attached
10 parallel with the fastener. Side panel 64 has a cooperating
11 member of the fastener 76 attached along one edge and a closure
12 strip parallel to the fastener.

13 The panels may also be fabricated with a selvage or hem or
14 can utilize a reinforcing tape such as "Polytape" that is made
15 from a polypropylene material. The selvage or tape may include
16 commercially available grommets or rings to accept the tie-down
17 hardware. The attachment ring 30 carries a self-locking clamp
18 32 adapted to fit the eyebolt 24 to tie down the curtain. In
19 Fig. 7 clamp 32 captures a rod 38 and clamps to the eyebolt
20 24. In the Fig. 8 embodiment the clamp 32 is fitted to a
21 sturdy rod 38 running the length of the bottom edge of the
22 barrier that is secured in the hem formed by folding the
23 material of the curtain as shown. In Fig. 8 the end cap 40

1 can serve as a glide in a track if end tracks (not shown) are
2 desired for raising and lowering the barrier. An automatic
3 deployment system could require such end tracks. The same
4 reference numerals depict like parts in all the Figs.
5 Commercially available grommets or attached rings 30 may be
6 utilized to hold the clamp 32. In this manner the curtain is
7 anchored via the clamp 32 and eyebolt 24. Rod 38 may include
8 an end cap 40 mounted on the end thereof to prevent the rod
9 from falling out of the loop of the curtain.

10 One method of rolling up the curtain in order to move it
11 out of the way when not in use requires a pull cord (not shown)
12 that is looped around the end of the rod 38. The free end
13 freely hangs and allows the operator to pull or release it to
14 roll up or let down the curtain as required. Ideally the
15 deployed curtain should only be sufficiently taut to take out
16 slack. If during the installation slack is left this should be
17 allowed for in calculating the said minimum spacing.

18 The edges at the top and bottom of each panel of the
19 curtain are folded over one or two times, forming a hem, to
20 assure the structural integrity of the panels. The side edges
21 of the curtains may be suitably attached to the siding of the
22 building (not shown) in which the material is wrapped around a
23 batten, such as batten 70, which is in turn fastened to the
24 wall with appropriate screws.

1 Alternative end fastenings are shown in Figs. 10 and 11
2 wherein the ends are overlapped and releasably secured one to
3 the other. In Fig. 10, the hemmed edge of side panel 62 is
4 connected to joining panel 63 using two parallel strips 98, 99
5 of cohesive releasable fastener material on each panel. The
6 joining panel 63 is releasably connected to side panel 64, as
7 shown in Fig. 11, through the hemmed edges which have
8 reinforcing tapes 95 and 96. A plurality of loops 94 are fixed
9 along the length of the edges with each loop threaded through
10 a ring 90. As shown, the loops 94 on panel 63 are connected to
11 releasable clamps 92. The clamps 92 cooperate with a double
12 ended ring 90. The double ended rings 90 are attached to the
13 loops on panel 64. To close the air gap at the extreme edges
14 of the panels, a cohesive fastener 99, such as Velcro, is
15 attached to both panels. The reinforcing tapes and the loops
16 may be of the same material as the barrier.

17 What is shown by this invention is a simple, adaptable,
18 transparent, economical, and aesthetically pleasing device that
19 is suitable to protect the building, doors and windows from the
20 forces of winds occasioned by hurricanes and the debris carried
21 by the winds. The textile barrier can either be removed and
22 stored in a very simple manner without requiring a lot of space
23 or could remain installed and either rolled, swung or slid out
24 of the way.

1 Although this invention has been shown and described with
2 respect to detailed embodiments thereof, it will be appreciated
3 and understood by those skilled in the art that various changes
4 in form and detail thereof may be made without departing from
5 the spirit and scope of the claimed invention.

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